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ABSTRACT

A mathematics and science program for gifted and talented junior high students in Brooklyn, New York was designed to provide accelerated and enriched instruction in mathematics and enriched instruction in science and computer science. This program was evaluated to determine the congitive and affective changes that would indicate student growth and positive effects of the program and to determine what aspects of the program could be improved. Results show: (1) increases in overall mathematics performance, but no gains in achievement related to geometry or real numbers; (2) increases in overall science and biology achievement, but no gains in chemistry achievement; (3) positive student attitudes (toward school) at the beginning of the school year, but no increase during the year; (4) large gains in all areas of the computer science test; and (5) positive parent ratings of student performance in 14 school-related behaviors. In addition, subjects who belonged to a school computer club outperformed students who did not belong to the club. Recommendations are offered based on these and other findings. Two suggestions offered are to devote more class time to teaching chemistry and to revise the program's admission policy. (JN)

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Evaluation of a Science/Mathematics Gifted Education Program for Junior High School Students

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Running Head: EVALUATION OF A GIFTED EDUCATION PROGRAM

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ABSTRACT

An evaluation of a junior high school program providing accelerated and enriched instruction in mathematics, and enriched instruction in science and computer science is described. Increases in achievement were found for all three courses, though a subtest analysis of the science test revealed a gain in biology but not chemistry. Attitudes toward school were in the positive range but did not increase during the year. Parent ratings of student performance in 14 school-related behaviors were positive. The results are discussed according to achievement, attitudes, and opinions for each course, and in regard to general program issues.

I--INTRODUCTION

This report describes an evaluation of a mathematics and science program for gifted and talented junior high school students. The main focus of the study was on the math, science and computer science performance of the 7th grade class, entering in the fall of 1983. The evaluation was directed at determining the cognitive and affective changes that would indicate student growth and positive effects of the program, and determining what aspects of the program could be improved.

1.1 Acceleration and Enrichment

Acceleration is the attempt to shorten the period of formal education (Fliegler, 1961), the methods of which include early admission to school, advanced placement, grade-skipping, and rapid progress through subject matter. Reynolds and Birch (1977) classify acceleration into two types: 1) age/grade acceleration, where the pupil moves ahead to join older pupils, and 2) curriculum acceleration, where skills or content are taught to a group of students at an earlier age than usual.

Enrichment is the provision of some type of additional educational experience which supplements regular classroom activities, and is made available to students who are able to complete the regular activities more rapidly and more competently then the majority of students (Vernon, Adamson, & Vernon, 1977). The concept of enrichment usually refers to the 'horizontal' rather than 'vertical' extension of subject matter. It is not intended for the advancement of the gifted child to a higher level, but is instead used to provide broader or deeper knowledge and experience at the same level as the majority of children the same age.

1.2 Mathematics Instruction

Some of the focus of new programs in mathematics for the academically talented child has been toward developing a planned system of enrichment to the regular class curriculum, and may involve problems and exercises that are an expansion of the fundamental topic being presented (Waters, 1980).

Recently, however, impressive results in using age/grade acceleration methods in mathematics such as early admissions, grade skipping, covering two or more years of mathematics instruction in one year, and obtaining college credit through examinations have been demonstrated by the Study of Mathematically Precocious Youth, or SMPY (Stanley,

1978, 1980; Fox, 1974; George, 1976). In spite of these results, the practice of age/grade acceleration itself has not been fully accepted by the academic community, often due to concerns that acceleration may prevent a child from maintaining satisfying social and emotional adjustment (Weinstein, Mitchell, Schwartzstein, and Hirschhorn, 1966).

An alternative has been to accommodate gifted children through curriculum acceleration, such as the Accelerated Program In Elementary School Mathematics (Suppes & Hansen, 1965; Suppes, 1966; Suppes and Ihrke, 1970). Another approach has been to "balance" a mathematics curriculum between acceleration and enrichment (Foley and Spack, 1979).

Still another approach has been to develop a curriculum based on the rationale that the ability to think mathematically is more important for the gifted, rather than increasing the "store" of mathematical information (Warvik, 1980).

1.3 Science Instruction

The era of space exploration which began with Sputnik had increased pressure on schools to upgrade science/mathematics curricula, especially for gifted children. A set of fundamental guidelines for gifted education in science was presented by a joint conference of

the National Education Association Project on the Academically Talented Student and the National Science Teachers Association (1959). These guidelines emphasized (among other things): in-depth study in a few chosen fields of science rather than broad instruction in diverse topics, emphasis on the influences of science on other areas of culture (e.g., politics, economics, and standard of living), emphasis on the development of the concepts, principles, generalizations and issues of science rather than the accumulation of unrelated facts, and the utilization of science resources in the community for the purpose of enriching and supplementing a program of study.

Daddario (1977) claimed that the scientific experience for children should be made more stimulating for them, partly because the scientific community tends to attract a large share of talented and gifted individuals. It has also been argued that gifted students should be taught science in the context of its own history, so that the learner will experience for his or her self the development of scientific thinking (Martin, 1979).

One approach to providing special science instruction to gifted children has been the establishment of summer programs, such as the Research Team Approach to Learning, or ReTAL (Del Giorno, 1977). The ReTAL program was designed to provide students with an experience that parallels the

intellectual process of building a hierarchy of thinking operations, which supposedly is used by researchers and scientists when trying to reach a research goal.

A second method has been through after school and Saturday programs, such as the programs for 7th through 12th grade gifted students at the Talcott Mountain Science Center (Atamian and Danielson, 1977). Under the guidance of the center staff members, this center has provided students with opportunities to pursue individual or small-group research projects on topics of their choice, creating an environment analogous to the graduate student-professor relationship at universities.

A third approach is the establishment a special enriched curriculum during the course of regular school day, such as the program at the Bronx High School of Science (Kopelman, Galasso, and Strom, 1977).

1.4 Computer Science Instruction

The results of Project Solo (Dwyer, 1971, 1974) led Dwyer to conclude that computer related technologies and concepts are able to offer educational experiences that not only help the student to achieve a certain amount of control over the external environment, but also provide the student a greater degree of internal self-control. Dwyer claims

that computing in education can employ a heuristic method of teaching, where students are provided by the teacher with principles or guidelines that help them make decisions and discoveries when writing computer programs. In such an environment, the teacher functions as an "expert" to be consulted by the students in order to learn more and get a project to operate successfully.

A similar assessment has been put forth by Bell (1974), who argues that if students are given control over a computer in a computer-oriented environment, they will perceive that learning situation to be a different one from the traditional school setting of lectures, demonstrations, and discipline. Both Dwyer and Bell feel that the important principle in making computer-related learning effective is to provide the learner with considerable control over the computer hardware and software. Some evidence (Doorly, 1980) also supports the idea that accessibility of equipment may be a key factor.

Though incidents of success in computer programming instruction for gifted students have been documented (Larsen, 1979; Piele, 1979), little quantitative evidence has been provided. Data acquired through empirical research efforts would provide a more solid basis on which to evaluate its effectiveness.

1.5 Evaluation in Gifted Education

In situations where control groups have not been available, researchers have employed a single group pretest-posttest design in gifted program evaluation, arguing that the change in test scores for the program participants should in all likelihood be due to the program (Cooley and Bassett, 1960).

In other evaluations, researchers have employed groups of comparable students within the same school, within the same school district, or within an outside district as control subjects to compare with the gifted program participants (Wurster and Ball, 1976). Arends and Ford (1964) evaluated a science/mathematics program for gifted junior high school students by comparing participant performance with control subjects matched for IQ, age, and sex, and by comparing the performance of "average", non-gifted students who went through the same program with equivalent control subjects to demonstrate the ineffectiveness of the program for the average student.

II--DESCRIPTION OF THE PROGRAM

2.1 General Setting

The program under study -- which for the remainder of this report will be referred to as the MAGNET program -- is a science and math oriented gifted education program conducted in a junior high school in Brooklyn, New York. Magnet schools are those designed to draw students from an entire school district rather than from a special attendance zone (Schafer, 1979). The curriculum was designed with the expectation that the field of science would attract pupils from all areas of the district and encourage them to attend the school. The school is in a district comprised of 20 elementary schools and five junior high schools. There are three "feeder" elementary schools to the junior high under study -- a 6th grade student in any one of these schools may apply to the program. A large number of applicants, however, are from non-feeder district schools. These students, if they meet the admissions standards, are also eligible for enrollment.

In order to be admitted to the MAGNET program, applicants must have standardized reading test scores that are 2 or more years above grade level, and standardized math test scores that are 1 and 1/2 years or more above grade level. Incoming students must display a strong interest in

science, and should have an outstanding academic record.

The MAGNET program is conducted as a "school within a school", in that besides having their own specialized mathematics, science, and computer technology instruction, the students also have separate language, English, and social studies classes. MAGNET students are grouped with the non-MAGNET students only during lunch, physical education, school-wide assemblies, skating trips, movies, and several other school-wide activities. Thus, there is relatively little contact between the MAGNETs and other students.

2.2 Courses Under Study

The program is conducted for grades 7, 8, and 9, although due to limited resources, personnel, and time, the evaluation was limited to the performance of the seventh grade students in math, science, and computer science.

The 7th grade mathematics course provides enriched instruction and also uses the accelerated curriculum approach as described by Reynolds and Birch (1977). An eighth grade text is used. The course covers fractions, decimals, percents, ratios, the principles of real numbers and integers, positive and negative numbers, equations, graphs, functions, and geometry. The math course employs a

parallel programming system, whereby students are placed according to their ability into one of three classes, each of which works at different paces of instruction. Students are transferred to faster or slower classes of the basis of their performance.

The 7th grade science course provides enriched instruction in two major subject areas: biology and chemistry. Visual demonstrations of the concepts covered in lecture are conducted in the lab sessions, as well as such procedures as dissections, and the use of such equipment as microscopes. The topics covered in biology include the fundamentals of cell biology, basic structures of plant and animal cells, one-celled animals, cells of the human body, human anatomy, respiration, circulation, excretion, digestion, and locomotion. The chemistry unit includes such topics as the principles of matter, the structure of the atom, molecules, metals and non-metals, the concepts of atomic number and atomic weight, the organization of the periodic table, valence number, moles, radicals, types of chemical reactions, acids, bases, salts, ph, and basic organic chemistry topics such as sugars, fats, and proteins. The science course also includes some discussion of the scientific method, and the concepts of hypothesis, theory, and law.

The 7th grade computer science course offers enriched instruction in a laboratory setting consisting of 9 satellite computers and ancillary components linked to a "host" unit. General data processing topics covered in the computer class include the fundamentals of data processing, the purpose of computer languages, hardware, software, BIT, BYTES, MEMORY, ROM, RAM, INPUT, OUTPUT, and the main components of the computer. The programming language taught in this class is BASIC -- students are taught how to write, save, and run programs in this language, using such commands as RUN, LOAD, READY, REM, LIST, LET, PRINT, GOTO, IF-THEN, and FOR-NEXT-STEP. They are also taught how to perform mathematical operations on the computer, and about computer graphics. Students in this class are also provided with an exposure to the different types of computing errors, how these errors are to be corrected, and how programs are edited.

III--METHOD

3.1 Subjects

The subjects of this evaluation were all seventh grade students in the MAGNET program (N=81). This number fluctuated somewhat during the school year as students were dropped from or added to the program. In the beginning of the year there were 79 seventh grade students; the final number at the end of the year was 71.

3.2 Measures

3.2.1 Achievement To assess student progress in math, science, and computer science, three objective tests were written. Lists of specific objectives were prepared for each course after interviews with the program teachers. Teacher estimates of the portion of the school year devoted to major content areas, and of the portion of the content areas devoted to different processes were used as guides for the development of the test plans.

Four general content areas were covered in the 30-item mathematics test: 1) Fractions, Decimals, Percent and Ratio, 2) Real Numbers, 3) Equations, Graphs, Functions, and Variables, and 4) Geometry. The math process areas included

four categories: 1) Knowledge of Terms and Facts, 2) Comprehension of Principles and Concepts, 3) Simple Manipulation of Numbers (where the technique or operation to be performed was straight-forward), and 4) Problem Solving (where some decision on the appropriate technique needed to be made in order to solve the problem).

The 37-item science test covered five general content areas: 1) Scientific Method, 2) Cell Biology, 3) Anatomy, 4) Chemistry, and 5) Organic Chemistry. Four science test process areas were covered: 1) Knowledge of Terms, 2) Knowledge of Specific Facts, 3) Comprehension of Principles, and 4) Application of Principles to Novel Situations.

Five content areas were covered in the 40-item computer science test: 1) Data Processing Principles, 2) Fundamental BASIC Commands and Statements (e.g., RUN, LOAD, READY, REM, LIST, LET, PRINT), 3) Advanced BASIC Commands and Statements (e.g., GOTO, IF-THEN, FOR-NEXT-STEP), 4) Errors and Editing, and 5) Graphics. Four test process areas were covered in computer science: 1) Knowledge of Basic Terms and Vocabulary, 2) Comprehension of Principles, 3) Application of Principles, and 4) Analysis of Relationships (how one structure or command relates to another).

The test items, all multiple-choice, were written by the evaluation worker and presented to each of the teachers for comments and suggestions for improvement. Pre- and posttest reliability coefficients (KR-20) for each test appear in Table 1. Reliability coefficients were also obtained for the two science subtests: biology nd chemistry. While the biology subtest reliabilities were similar to those for the whole scale, the chemistry subtest reliabilities were very low, probably because of a large amount of guessing on these items.

Insert Table 1 about here

3.2.2 Attitudes To measure changes in student attitudes, a summative rating scale was constructed, containing 40 statements about school (20 positive, 20 negative). Examples of the positive statements used in the scale include: "I usually look forward to going to school", "It is important for me to get my schoolwork done on time", and "Some of my happiest moments are at school". Examples of negative statements include: "School makes my life

miserable", "I hate to sit through classes", and "To be a student is dull". The students responded to each statement along a seven point scale: -3 (Disagree very strongly), -2 (Disagree strongly), -1 (Disagree), +1 (Agree), +2 (Agree strongly), +3 (Agree very strongly). The pre- and posttest reliability coefficients (Coefficient Alpha) for the summative scale are included in Table 1.

3.2.3 Student Questionnaire The students were given a questionnaire which asked them to rate how they perceived the overall organization of the MAGNET program. The scale values were: 1-VERY POORLY ORGANIZED, 2-POORLY ORGANIZED, 3-AVERAGE ORGANIZATION, 4-WELL ORGANIZED, and 5-VERY WELL ORGANIZED.

They were also asked to rate the quality of the work in their Mathematics, Science, and Computer Science classes. The scale values for these three items were: 1-NO VALUE, 2-LITTLE VALUE, 3-AVERAGE VALUE, 4-QUITE VALUABLE, and 5-VERY VALUABLE.

The students were also presented with a list of general content areas for each of the courses, and were asked to rate their learning in each. The following scale values were used: 1-LEARNED VERY LITTLE, 2-LEARNED LITTLE, 3-LEARNED AVERAGE AMOUNT, 4-LEARNED MUCH, 5-LEARNED A GREAT DEAL.

The questionnaire also asked them to indicate if they had used a computer outside of school (a distinction was made between programming and running computer games), and contained an open-ended item calling for suggestions on how the program could be improved.

3.2.4 Teacher Questionnaire All seven of the 7th grade MAGNET teachers (3 math, 3 science, 1 computer science) were interviewed by the evaluation worker. Each teacher was presented with the list of general content areas for the course that he or she taught, and was asked to rate the MAGNET students' learning in each component, just as the MAGNET students had rated their learning in the same areas on the student questionnaire.

Teachers were also given open-ended questions on how they had conducted the MAGNET classes, the nature of which varied for the different subject teachers. Math teachers were asked to estimate class time spent reviewing old concepts and time spent beginning new topics. Science teachers were asked to estimate class time spent in discussion, the nature of the lab work, and how the lab work related to the material in lecture. The computer science teacher was asked to estimate class time devoted to lectures, the time students spent working at the terminals, and whether or not students worked alone. All of the

teachers were questioned about the nature of the work performed in class and the nature of the homework assignments given.

Teachers were also asked about their personal reactions to the program, including: their perceptions of the degree to which the program permitted them to contribute to the lessons, the adequacy of the facilities and equipment to assist student learning, the relevance of the program to the needs of the learners, and the compatibility of the program's views of the nature of science with their own views. The teachers were also asked about the students' attitudes toward learning, their own attitudes toward the students, the opportunities the program offered students to interact with the teachers and with other students, the strengths and weaknesses of the program, and their suggestions for program improvement.

3.2.5 Parent Questionnaire Parents were asked to report on pupil attitudes and behaviors which the children themselves may have been unable or reluctant to disclose. A 14-item questionnaire was constructed; each item contained a description of a school-related behavior. For each behavior, parents were asked to indicate how their child's performance during the school year compared with his or her performance during the previous school year. A five point

scale was used: 1- MUCH WORSE THAN LAST YEAR, 2-WORSE THAN LAST YEAR, 3-ABOUT THE SAME AS LAST YEAR, 4-BETTER THAN LAST YEAR, 5-MUCH BETTER THAN LAST YEAR.

3.2.6 Administrator Interviews The administrator interviews included questions about their perceptions of the MAGNET students' attitudes toward school, the impact of the program on teacher attitudes, the nature of the teacher selection process, facilities provided for the project, program scheduling difficulties, and evidence of community and district support and/or non-support for implementation of the program.

3.3 Design

To assess student growth in achievement and attitudes, the One-Group Pretest-Posttest Design was employed. The achievement tests were administered as pretests in September, 1983 and re-administered as posttests in June, 1984. The attitude scale was administered in October, 1983 and re-administered in May, 1984.

While the single group design is not the most ideal for evaluation, the lack of an equivalent control group made it the best available design for this study. Its weaknesses include possible invalidity due to maturation, history,

testing, instrumentation, regression toward the mean, and interactions (Campbell and Stanley, 1963). However, a number of these alternatives can be eliminated through logical means (Popham, 1975). For instance, invalidity due to instrumentation could be ruled out in this study since the same tests were used for pre- and posttesting. In the case of science and most likely mathematics, there was probably little chance that such specialized knowledge was obtained from a source in the school that was not part of the program. Such an assertion is supported by the fact that the MAGNET program is a "school within a school", whereby the MAGNET children have virtually no contact with non-MAGNET children. It would also seem unlikely that extensive science and math instruction could have been obtained by these students outside of the school.

However, in the case of computing, there was a possibility of contamination from at least 2 sources: 1) student access to a home computer, and 2) the program's Computer Club. Efforts to control for these variables are described in section 4.1.

All other measures were administered at various times during the later part of the 1983-84 school year.

IV--RESULTS AND DISCUSSION

4.1 Achievement Results

The results revealed a significant gain at the .01 level for the MAGNET students in their overall math, science and computer science performance, with respective posttest means of 50.8%, 51.1%, and 56.8% correct. The increase for the biology subtest of the science test was also significant. The chemistry subtest mean, however, was not significantly higher, though the chemistry means are based on very unreliable measures. This result was to be expected in light of the fact that little or no chemistry was covered by the teachers during the school year.

Analyses were also performed on each of the test content areas. Small scales such as these cannot be expected to be as reliable as full tests, although significantly higher posttest scores were found for Fraction/Decimals and Equations in math, Cell Biology and Anatomy in science, and all five of the computer science content areas. The pre- and posttest results for all three courses appear in Table 2.

Insert Table 2 about here

No difference in computer science performance was found between students who reported using a home computer and students who reported that they did not. However, students who belonged to the computer club significantly outperformed those who were not members on the computer science test. It is not certain, however, that the club itself caused students to perform higher. It is possible that an unaccounted-for variable which correlated with the computing club variable had actually effected performance. The results for the home computer and computer club variables appear in Table 3.

Insert Table 3 about here

4.2 Attitude Scale Results

The minimum, or lowest possible negative summative score on the Attitudes Toward School Scale was -90, while the maximum, or greatest possible positive score was +90. The posttest mean did not differ significantly from the pretest mean (see Table 2). It is possible that initial excitement among the students over entering a special program may have been present at the beginning of the school year, which in turn may have artificially inflated the student's pretest scores on the scale. This initial good feeling could have worn off after several months of program operation, and may have masked any true increases in attitudes at posttesting.

It is also possible that the average score for students could have been significantly lower in September, when they were just entering the program, and any positive changes in attitudes might have reached a pinnacle for these students by the time of pretesting in October.

But while there was no significant increase in attitudes at posttesting, the results are encouraging in that there was no significant decrease. The MAGNET students seemed to maintain, on the average, positive feelings toward school throughout the year. While it could be argued that these students might have also displayed such attitudes had

they not been in the program, the evidence seems to refute the hypothesis that the program had a negative effect. Moreover, the stature of the program is enhanced when considering these results along with the generally positive reports of student attitudes obtained from teachers and parents.

4.3 Student Questionnaire Results

The average student rating for the organization of the whole program was equal to WELL ORGANIZED(4), and the average ratings of the value of the work in the mathematics and science classes were both between AVERAGE VALUE(3) and QUITE VALUABLE(4), indicating that there generally was positive regard for these aspects of the program. An even higher rating (between QUITE VALUABLE and VERY VALUABLE(5)) was obtained for computer science. The results appear in Table 4.

Insert Table 4 about here

Summaries of the student ratings of the amount learned in each course component revealed especially high (between LEARNED MUCH(4) and LEARNED A GREAT DEAL(5)) ratings for Fractions/Decimals and Solving Equations in math, Structures of the Cell and Human Anatomy in science, and all of the content areas in computer science. The relative standing of these ratings coincide sharply with the t-test results.

Somewhat lower ratings (between LEARNED AVERAGE AMOUNT(3) and LEARNED MUCH(4)) were found for the Scientific Method and Organic Chemistry sections. Ratings below LEARNED AVERAGE AMOUNT were obtained for Positive and Negative Numbers, Real Numbers and Integers, Geometry, and Chemistry (non-organic). The student ratings for the course components appear in Table 5.

Insert Table 5 about here

4.4 Teacher Questionnaire Results

The MAGNET teacher ratings of student learning were largely in agreement with the ratings made by the students. Areas given relatively high ratings by the students (i.e., Fractions and Decimals, Solving Equations, Structures of the Cell, Human Anatomy, Data Processing Terms, the BASIC language, and Computer Errors) were also judged by the teachers as being well learned by their classes. Conversely, areas given low ratings by the students (e.g., Positive and Negative Numbers, Real Numbers and Integers, Chemistry and Organic Chemistry) were given lower ratings or none at all by the math teachers. The teacher ratings are summarized in Table 6.

Insert Table 6 about here

Space does not permit a detailed discussion of the results of the interviews with MAGNET teachers, though the basic findings have been summarized below.

4.4.1 Interview Results for Mathematics Teachers

Math

teachers reported spending about 20% of the class time in review of concepts taught during previous lectures, and between 30% and 60% of the class periods covering new material. Homework assignments were given every night from the textbook. All of the math teachers felt they could, within limits, teach their lessons as they pleased, and in fact had desired more direction in what to teach. The ratings of the math textbook by the MAGNET teachers ranged from adequate to excellent, particularly the book's assignments. Math teachers in general felt that the students were getting a good foundation in fundamental topics that they could use in later school years, though one teacher felt that some students were unprepared for the work. Math teachers had mixed perceptions of student attitudes toward school, ranging from generally positive to somewhat negative. Their own attitudes toward the students were also mixed. There were few opportunities during the actual class periods where individual students could interact directly with the math teachers. Students also had little opportunity to interact with each other during the math classes.

4.4.2 Interview Results for Science Teachers Science teacher estimates of the proportion of time spent in class discussion ranged from 25% to 70%. All three reported a close correspondence between the material covered in science

lecture and the laboratory work. Students received homework assignments 3 to 4 times per week, which usually consisted of thought questions or lab reports. None of the MAGNET science teachers felt particularly constrained by the curriculum, although as in the case with mathematics, one science teacher commented that the program would benefit by developing a more detailed curriculum. Two teachers felt that the students' experiences in lab were too restricted by the equipment. All three science teachers strongly believed that the science program was relevant to the needs of the learners, and will prepare them well for science in high school. Two teachers had major differences with the program's views of the nature of science. The science teachers had a favorable impression of the seventh grade students' attitudes toward their schoolwork, and their own attitudes toward the students were also generally positive. The aspects of the program that offered opportunities for students to interact with the science teachers included the labs, the clubs, the trips, and after school. The lab periods were also judged as fostering productive interactions between the students themselves.

4.4.3 Interview Results for Computer Science Teacher The computer science instructor estimated that about 70% of each class was devoted to the laboratory activities, and that about 25% of each class period was devoted to lecturing.

Students were usually able to work alone at each terminal on their own programs. The teacher claimed that the activities conducted during the lab portion were always related to the topic covered during the lectures. Usually, the lab exercises were problem solving activities, such as writing sample programs, or debugging a faulty program. The homework assignments related to the lessons and activities in class. The computer science teacher felt free to make his own contributions to the lessons, within a general set of guidelines. The instructor rated the equipment in the computing lab as excellent for the needs of the MAGNET classes. He believed that the curriculum was relevant to the needs of the learners in that it made them aware of the capabilities of computers, and thoroughly familiarized them with a computer language. He felt that the MAGNET students' attitudes toward learning were, in general, very enthusiastic in during computing class. He described his own perception of the MAGNET students as positive, though he felt that the experience could be made more challenging both for him and for the students through the introduction of the PASCAL language in the curriculum. The laboratory arrangement permitted the computing instructor to engage in frequent interactions with the MAGNET students, and introduced a "team spirit" in the class, encouraging students to try to answer questions amongst themselves, rather than to immediately seek out the teacher for answers.

4.4.4 Teacher Nominations of Program Strengths MAGNET teachers most often made the following comments when describing the strengths of the MAGNET program: "the students are motivated", "the students are well prepared for the work", "the MAGNET faculty is highly competent", "teachers can spend more time teaching and less time disciplining", "good cooperation has been demonstrated by parents and the general community", "the parallel programming method in math is very useful", and "the MAGNET program has affected the rest of the school in a positive manner".

4.4.5 Teacher Nominations of Program Weaknesses The following comments were most often made by the MAGNET teachers when describing the weaknesses of the program: "some students do not belong in the program and should be removed", "not all students are well motivated", "the program encourages student elitism ", "the interactions between teachers are poor", "too much time is spent constructing exhibits for parents", and "the school is as a bad environment for the MAGNET students".

4.5 Teacher and Student Suggestions for Improvement

The following suggestions were most often made by teachers as ways to improve the MAGNET program: "modify the student selection procedure", "remove poor and disruptive students", "provide more direction for teachers in what they should teach", "improve the coordination of teacher activities", "develop a more stable curriculum", and "provide more time for teachers to help students with problems".

The following suggestions were most often made by students as ways to improve the MAGNET program: "remove disruptive students", "improve the teaching staff", "improve the science facilities", "devote more time to math/science/computer science", "have more/less work", "have more trips", "have longer school days/periods", "provide more school security", and "have more elective courses".

4.6 Parent Questionnaire Results

For all 14 of the school-related behaviors described in the questionnaire, the average parent ratings of child performance were in the positive range - either between ABOUT THE SAME AS LAST YEAR(3) and BETTER THAN LAST YEAR(4), or between BETTER THAN LAST YEAR and MUCH BETTER THAN LAST YEAR(5). The list of items, presented in the order of

greatest improvement to least improvement, appears in Table 7.

Insert Table 7 about here

However, since only 42 out of a possible 71 questionnaires had been returned, the mean outcomes in each case may be spurious, and may actually have been much lower for the entire group of parents - it is possible that the parents of the students who performed poorly may have tended to be indifferent to filling out the questionnaire. Moreover, even if it can be assumed that the parents who responded did so in a manner that was representative of the entire group of parents, it is not certain that the improvement in performance over the previous year was due solely to the MAGNET program. Many improvements, such as thinking logically, learning new things on their own, and showing curiosity about new things may have been due to maturation. Or, some event outside school during the course of the school year (e.g., a television documentary) may have actually incited the students to show more interest in

science or mathematics, rather than the MAGNET program itself.

On the other hand, such behaviors as showing enthusiasm about going to school, doing extra-curricular work, sharing school experiences at home, and appearing to like school in general probably had been influenced by the school at least to some degree, and therefore would seem to indicate that the program did have some positive outcomes. Thus while one cannot attribute the positive changes in the students as reported by the parents directly to the program, one can probably conclude with reasonable certainty that the program has not had an adverse effect on the students in these areas. Furthermore, at least according to the parents who responded to the questionnaire, it would seem likely that the program had to some extent produced a positive effect.

4.7 Administrator Interview Results

The administrators had been pleased with the enthusiasm that the MAGNET students demonstrated during the school year, as demonstrated by their high performance and their active participation in extra-curricular activities. They reported that the program encountered good cooperation from local community institutions such as hospitals and universities in arranging trips for the MAGNET students. They also received very enthusiastic comments from parents,

both verbally and in writing.

One administrator felt that that the majority of the MAGNET teachers were motivated, diligent, and very enthusiastic about working with the MAGNET students, though he also believed there was some room for improvement.

V--SUMMARY AND RECOMMENDATIONS

Students made significant gains in overall math performance, although they did not gain in geometry or real numbers. Student ratings of the math course were generally positive. They also scored significantly higher in total science and in biology, but no gains were made in chemistry. Student ratings of the value of the science course were positive. Large gains were made in all areas of the computer science test. Student ratings of the value of the computer course were also highly positive. Subjects who belonged to the computer club outperformed those who did not.

Students also felt the program in general was well organized. Their attitudes toward school remained consistently positive during the beginning and the end of the year, though they did not increase. Parents who participated in the study reported positive changes in their children's school behavior during the year. Teachers in general were satisfied with the program, with some reservations.

With respect to attitudes, it appears that few improvements need to be made since the program is being positively received by the student body. Their ratings of

the program and the individual subjects, plus the favorable assessments by parents about their childrens' enthusiasm with school suggest that the MAGNET program has been largely successful along these dimensions.

With respect to achievement, the outcome is more questionable. While the tests used to evaluate achievement were custom-built for each course, the average scores for math, science and computer science at the end of the school year were only around 50% correct. One may take the point of view that the program students had in general performed poorly in relation to the objectives that were set in the beginning of the year.

It seems reasonable to conclude that more class time should to be devoted to chemistry by the science instructors, and more time should be devoted to real numbers, positive and negative numbers, and to geometry by the math instructors. Efforts to replenish the equipment shortages in science (e.g., scales, microscopes, chemicals and glassware) and improve the science facilities probably would be appropriate in order to facilitate instructors in meeting their educational goals.

An effort to revise the program's admissions policy is also a priority for program improvement. It also appears necessary to modify the conditions for removing poor

students. It may be helpful to try to accommodate the poorer students, while at the same time removing them as a distraction or a hindrance to the more able students. Comments made by the math teachers about the parallel programming system were highly favorable -- it may be to the program's benefit to institute a similar system in the science classes. Admittedly, this may cause unforeseen scheduling difficulties, but the difficulties may be outweighed by the benefits to students who are not learning in certain classes, who are disruptive to other students, and who would otherwise face expulsion from the program. It may also reduce the frustration of science teachers whose students are not performing well.

Undoubtedly, such a system would require close coordination between the different classes in order to make the transition from one class to another as smooth as possible for each student. This leads to a second recommendation for program improvement, and that is the development of stricter and more uniform curricular guidelines for each subject area. Some of the teachers had said that they had too much freedom in what they were to teach, and would have preferred to have a more clearly specified curriculum. A large degree of diversity in the instructional approaches used by the science teachers had been found, and this may be evidence of this lack of

uniformity. The establishment of a master teacher for each course to direct the activities of the other teachers may be an appropriate solution. Also, the development of stricter instructional guidelines and time-tables, such as when biology instruction should end and when chemistry instruction should begin, could prevent certain topics from becoming under-emphasized and others from becoming over-emphasized in different classes.

Another recommendation is to convene periodic meetings of all MAGNET instructors, to help to establish better understanding of common goals and better working relationships between the teachers, thus permitting them to coordinate the activities of the different subjects in a more meaningful manner for the students.

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TABLE 1: RELIABILITY COEFFICIENTS FOR MATHEMATICS, SCIENCE, AND COMPUTER SCIENCE TESTS, AND ATTITUDE SCALE

	Items	Pre-test ALPHA	Post-test ALPHA
Mathematics	30	.64	.84
Science	37	.47	.78
Biology	21	.49	.78
Chemistry	14	.16	.27
Computer Science	40	.64	.80
Attitudes Toward School	30	.93	.94

TABLE 2: T-TESTS FOR PRE- AND POST- TREATMENT SCORES FOR MATHEMATICS, SCIENCE, COMPUTER SCIENCE, AND ATTITUDES TOWARD SCHOOL

		PRE-TEST		POST-TEST		
	N	Mean	SD	Mean	SD	t
Total Math (30)	63	12.2	4.1	15.3	5.9	5.2*
Fractions (9)	63	4.5	1.7	5.7	2.4	4.9*
Real Numbers (5)	63	1.6	1.0	1.7	1.0	.8
Equations (12)	63	4.1	2.1	5.8	2.5	5.3*
Geometry (4)	63	2.0	1.1	2.1	1.4	.5
Total Scien (37)	64	15.0	3.6	18.9	5.5	4.9*
Scien Meth (2)	64	1.0	.9	1.3	.9	2.1
Total Bio (21)	64	9.7	2.7	12.9	4.1	5.7*
Cell Bio (8)	64	3.2	1.7	5.3	1.9	6.9*
Anatomy (13)	64	6.5	1.9	7.6	2.6	3.2*
Total Chem (14)	64	4.2	1.8	4.7	1.9	1.3
Non-organic (11)	64	2.9	1.5	3.0	1.5	.4
Organic (3)	64	1.4	.9	1.7	1.1	2.1
Total Comp Sci (40)	66	12.3	4.3	22.7	5.9	13.9*
Data Process (3)	66	.9	.7	2.1	.9	8.6*
Fund Basic (18)	66	[illegible]	2.5	11.4	2.7	15.3*
Adv Basic (11)	66	2.5	1.6	5.1	2.4	7.7*
Errors (4)	66	1.3	1.1	2.2	1.1	4.8*
Graphics (4)	66	1.1	1.0	1.9	1.1	5.7*
Attitudes (30)	65	26.9	32.8	27.6	33.2	.2

* $p < .01$

(Number of items appear in parentheses)

TABLE 3: COMPUTER SCIENCE PERFORMANCE BY HOME COMPUTER AND COMPUTER CLUB VARIABLES

HOME COMPUTER			NO HOME COMPUTER			
N	Mean	SD	N	Mean	SD	t
33	23.8	6.5	33	21.5	5.5	1.6

CLUB MEMBERS			NON-MEMBERS			
N	Mean	SD	N	Mean	SD	t
17	26.7	5.7	50	21.3	5.6	3.5*

* $p < .01$

TABLE 4: SUMMARY OF STUDENT REACTIONS TO INDIVIDUAL COURSES AND TO PROGRAM IN GENERAL

	MEAN	SD	N
Organization of the PROGRAM IN GENERAL	4.0	.9	68
Value of the work in MATHEMATICS class	3.7	1.2	68
Value of the work in SCIENCE class	3.6	1.5	68
Value of the work in COMPUTER SCIENCE class	4.3	.9	68

(Scale values range from 1-Very Low to 5-Very High)

TABLE 5: SUMMARY OF STUDENT REACTIONS TO COMPONENTS OF EACH COURSE

	MEAN	SD	N
MATHEMATICS:			
Fractions, decimals, percent and ratio	4.2	1.0	68
Positive and negative numbers	2.5	1.4	66
Real numbers and integers	2.4	1.3	66
Solving equations	4.0	1.3	68
Geometry	2.7	1.3	66
SCIENCE:			
Scientific method	3.4	1.5	68
Structures of the cell	4.4	1.1	68
Human anatomy	4.4	1.0	67
Chemistry (non-organic)	2.3	1.4	62
Organic chemistry	3.4	1.1	63
COMPUTER SCIENCE:			
Data processing terms	4.3	1.0	68
BASIC programming language	4.5	.8	68
Computer errors	4.0	1.1	68
Computer graphics	4.5	.8	68

(Scale values range from 1-Very Low to 5-Very High)

TABLE 6: SUMMARY OF TEACHER REACTIONS TO STUDENT LEARNING

	FREQUENCY OF RATINGS					
	N	1	2	3	4	5
MATHEMATICS:						
Fractions,decimals,percent,ratio	3		1		2	
Positive & negative numbers	1		1			
Real numbers and integers	1		1			
Solving equations	3		1		2	
Geometry	2		1		1	
	N	1	2	3	4	5
SCIENCE:						
Scientific method	3			2	1	
Structures of the cell	3				1	2
Human anatomy	3				2	1
Chemistry (non-organic)	0					
Organic chemistry	1	1				
	N	1	2	3	4	5
COMPUTER SCIENCE:						
Data processing terms	1					1
BASIC programming language	1					1
Computer errors	1				1	
Computer graphics	1			1		

(Ratings range from 1-Very Low to 5-Very High)

TABLE 7: SUMMARY OF PARENT QUESTIONNAIRE RESULTS

	MEAN	SD	N
Shows curiosity about new things	4.4	.8	42
Appears to enjoy learning	4.3	.8	41
Shows interest in science	4.3	.9	42
Demonstrates an ability to learn things on his or her own	4.2	.8	41
Shows an ability to think logically	4.1	1.0	42
Appears to like school in general	4.1	1.0	41
Shows enthusiasm about going to school	4.0	1.0	40
Shares school experiences at home	3.9	.9	42
Maintains good study habits	3.8	.8	41
Quality of completed homework assignments	3.8	1.0	41
Spends time reading in preparation for school	3.8	.9	42
Talks about completing homework	3.7	1.0	42
Shows interest in mathematics	3.6	.9	42
Spends time doing extra-curricular work at school	3.6	1.0	40

(Scale values range from 1-Much worse to 5-Much better)